Φ meson propagation in a hot hadronic gas*

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The Φ is a nice probe for the properties of the matter created in ultra-relativistic heavy ion collisions. It decays into kaon pairs, and more rarely into dileptons; both channels have been detected at CERN-SPS.

It is widely believed that the Φ mean free path (MFP) in a hot hadronic fireball is large due to the small cross section for scattering with non strange hadrons. This implies that Φ spectra would retain the information about the stage of the collision at which the plasma hadronizes [1]. Available calculations [2] seem to support this idea. However, Φ production in $Pb-Pb$ collisions at SPS shows some intriguing features that are difficult to match with the picture of a Φ weakly interacting with the hadronic medium. Both absolute yields and inverse slope parameters in the transverse mass distributions exhibit different values when measured via $\mu^+\mu^-$ or K^+K^- decays. The modification of visible Φ spectra due to kaon re-scattering inside the fireball is an important correction but does not fully explain the discrepancies [3].

We have calculated Φ collision rates and MFP in a hot hadronic gas of pseudo-scalar (π, K) and vector mesons (ρ, ω, K^*, Φ). The reaction cross sections are obtained within the Hidden Local Symmetry Lagrangian [4], which includes both Goldstone bosons and vector mesons in a manner consistent with the symmetries of QCD. The use of such a realistic model allows us to take into account many mechanisms that are not present in calculations that rely only in couplings extracted from observed decays but are allowed by the symmetries. As a consequence, we see that at temperatures between 150 and 200 MeV the Φ MFP in hadronic matter is considerably smaller than what has been estimated so far.

Finally, using a simple model for the expansion dynamics we find a moderate (20 %) reduction of the Φ-yield due to this re-scattering. Our findings thus cannot explain the difference between the observed Φ-mesons yields in the leptonic and hadronic channel at CERN-SPS.

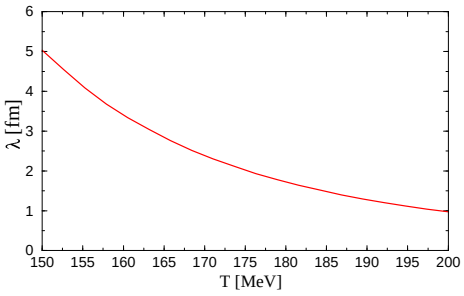

Figure 1: Φ MFP as a function of temperature.

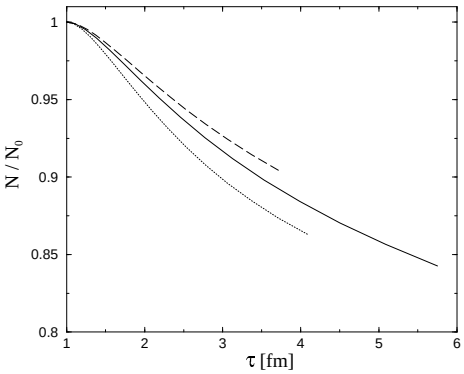

Figure 2: Time dependence of the ratio N/N_0 at zero (solid line) and nonzero (dashed line) chemical potentials. The dotted line stands for the case of $\mu_{K^*}=0$ while keeping $\mu_{\pi,K,\rho,\omega}\neq 0$.

References

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